

WHAT IS CLAIMED IS:

1. A suction nozzle for holding an electric component by suction, comprising:

a nozzle body;

a suction pipe disposed on said nozzle body and operable to hold said electric component by suction under a negative pressure at a sucking end thereof; and

a fiducial mark disposed on said nozzle body and located at a position at which an image of said fiducial mark can be taken concurrently with an image of said electric component held by said suction pipe, in a longitudinal direction of said suction pipe toward said sucking end.

2. A suction nozzle according to claim 1, wherein said fiducial mark is provided at an end of a pin which extends from said nozzle body in parallel with said suction pipe.

3. A suction nozzle according to claim 2, wherein said fiducial mark is defined by an end face formed at said end of said pin.

4. A method of detecting a position of an electric component held by suction by a suction nozzle under a negative pressure, relative to a nominal position of a suction pipe of said suction nozzle, by processing an image of said electric component taken in a longitudinal direction of said suction pipe

toward a sucking end of said suction pipe, said method comprising the steps of:

providing a fiducial mark near said suction pipe;

moving said electric component held by said suction pipe, and said fiducial mark, such that said electric component and said fiducial mark pass a field of vision of an image-taking device;

activating said image-taking device to concurrently take images of said electric component and said fiducial mark during movements thereof; and

processing said images taken by said image-taking device, to obtain a relative position between said fiducial mark and said electric component, and obtaining said position of said electric component relative to said nominal position of said suction pipe, on the basis of the obtained relative position between said fiducial mark and said electric component, and a known relative position between said fiducial mark and said nominal position of said suction pipe.

5. A method of detecting a position of an electric component held by suction by a suction nozzle under a negative pressure, relative to a nominal position of a suction pipe of said suction nozzle, by processing an image of said electric component taken in a longitudinal direction of said suction pipe toward a sucking end of said suction pipe, said method comprising the steps of:

providing a fiducial mark near said suction pipe;

taking an image of an end face of said sucking end of said suction pipe and an image of said fiducial mark;

processing said images to detect a relative position between said end face of said suction pipe and said fiducial mark;

holding said electric component by suction on said sucking end of said suction pipe, and taking images of said electric component held by said suction pipe and said fiducial mark; and

processing said images of said electric component held by said suction pipe and said fiducial mark, for determining a peripheral profile of said end face of said suction pipe which partially projects beyond a peripheral profile of said electric component, on the basis of the detected relative position between said end face and said fiducial mark, and for obtaining said position of said electric component relative to said nominal position of said suction pipe, while taking account of the determined peripheral profile of said end face of said suction pipe.

6. A method of detecting a bending of a suction pipe extending from a nozzle body of a suction nozzle arranged to hold an electric component by suction at a sucking end of said suction pipe under a negative pressure, said method comprising the steps of:

providing a fiducial mark near said suction pipe;

taking an image of an end face of said sucking end of said suction pipe and an image of said fiducial mark in a longitudinal direction of said suction pipe toward said sucking end; and

processing said images of said end face and said fiducial mark, to obtain a relative position between said fiducial mark and said end face, and detecting said bending of said suction pipe on the basis of the obtained relative position between said fiducial mark and said end face.

7. A method according to claim 6, wherein a plurality of fiducial marks are disposed at respective positions near said suction pipe, and said bending of said suction pipe is detected by processing images of said plurality of fiducial marks and said end face of said suction pipe.

8. A method of determining an angular position of a suction nozzle about an axis of rotation thereof, said suction nozzle including a nozzle body rotatable about said axis of rotation, and a suction pipe disposed on said nozzle body so as to be substantially coaxial with said nozzle body and operable to hold an electric component by suction at a sucking end thereof under a negative pressure, said method comprising the steps of:

providing a fiducial mark at a position spaced from said axis of rotation of said suction nozzle;

taking an image of said fiducial mark in a longitudinal direction of said suction pipe toward said sucking end; and

determining said angular position of said suction nozzle by processing said image of said fiducial mark.

9. A method according to claim 8, wherein

an image of an end face of said sucking end of said suction pipe is taken as well as the image of said fiducial mark, and said angular position of said suction nozzle is determined on the basis of a position of said fiducial mark and a position of said end face of said suction pipe.

10. A method of establishing a predetermined angular position of a suction nozzle on the basis of an actual angular position of said suction nozzle determined according to a method as defined in claim 8.

11. An electric-component handling device comprising:

a suction nozzle including (a) a nozzle body, and (b) a suction pipe extending from said nozzle body;

a fiducial mark disposed at a predetermined position relative to said suction pipe;

an image-taking device operable to take an image of an electric component held by suction by said suction pipe, and an image of said fiducial mark, in a longitudinal direction of said suction pipe;

a relative-movement device operable to move said image-taking device and said suction nozzle relative to each other, in at least a direction intersecting said longitudinal direction of said suction pipe, so as to pass a relative position therebetween at which said electric component held by said suction pipe and said fiducial mark are concurrently located within a field of

vision of said image-taking device; and

an image data processing device operable to process said images of said electric component and said fiducial mark taken by said image-taking device, for obtaining a relative position between said fiducial mark and said electric component, and to obtain a position of said electric component relative to a nominal position of said suction pipe, on the basis of the obtained relative position between said fiducial mark and said electric component, and a known relative position between said fiducial mark and said nominal position of said suction pipe.

12. An electric-component handling device comprising:

a suction nozzle including (a) a nozzle body, and (b) a suction pipe extending from said nozzle body and a sucking end;

a fiducial mark disposed at a predetermined position relative to said suction pipe;

an image-taking device operable to take a set of images of an end face of said sucking end of said suction pipe and said fiducial mark, and a set of images of an electric component held by said suction pipe and said fiducial mark, in a longitudinal direction of said suction pipe;

a relative-movement device operable to move said image-taking device and said suction nozzle relative to each other, in at least a direction intersecting said longitudinal direction of said suction pipe, to a relative position therebetween at which said suction nozzle and said image-taking device are opposed to

each other; and

an image data processing device operable to process said images of said end face of said suction pipe and said fiducial mark taken by said image-taking device, for detecting a relative position between said end face and said fiducial mark, and to process said images of said electric component and said fiducial mark, for determining a peripheral profile of said end face of said suction pipe which partially projects beyond a peripheral profile of said electric component, on the basis of the detected relative position between said end face and said fiducial mark, and obtaining a position of said electric component relative to a nominal position of said suction pipe, while taking account of the determined peripheral profile of said end face of said suction pipe.

13. An electric-component handling device comprising:

a suction nozzle including (a) a nozzle body, and (b) a suction pipe extending from said nozzle body and a sucking end;

a fiducial mark disposed at a predetermined position relative to said suction pipe;

an image-taking device operable to take an image of an end face of said sucking end of said suction pipe and said fiducial mark, in a longitudinal direction of said suction pipe;

a relative-movement device operable to move said image-taking device and said suction nozzle relative to each other, in at least a direction intersecting said longitudinal direction of

said suction pipe, to a relative position therebetween at which said suction nozzle and said image-taking device are opposed to each other; and

an image data processing device operable to process said images of said end face of said suction pipe and said fiducial mark taken by said image-taking device, to obtain a relative position between said fiducial mark and said end face, and to detect a bending of said suction pipe on the basis of the obtained relative position between said fiducial mark and said end face.

14. An electric-component component handling device comprising:

a suction nozzle including (a) a nozzle body, and (b) a suction pipe extending from said nozzle body and a sucking end;

a fiducial mark disposed at a predetermined position relative to said suction pipe;

an image-taking device operable to take an image of said fiducial mark in a longitudinal direction of said suction pipe;

a relative-movement device operable to move said image-taking device and said suction nozzle relative to each other, in at least a direction intersecting said longitudinal direction of said suction pipe, to a relative position therebetween at which said suction nozzle and said image-taking device are opposed to each other; and

an image data processing device operable to process said image of said fiducial mark taken by said image-taking device, to determine an angular position of said suction pipe.



15. An electric-component handling device according to claim 11, wherein said fiducial mark is disposed on said nozzle body such that said fiducial mark is spaced from said suction pipe in a radial direction of said suction pipe.

16. An electric-component handling device according to claim 12, wherein said fiducial mark is disposed on said nozzle body such that said fiducial mark is spaced from said suction pipe in a radial direction of said suction pipe.

17. An electric-component handling device according to claim 13, wherein said fiducial mark is disposed on said nozzle body such that said fiducial mark is spaced from said suction pipe in a radial direction of said suction pipe.

18. An electric-component handling device according to claim 14, wherein said fiducial mark is disposed on said nozzle body such that said fiducial mark is spaced from said suction pipe in a radial direction of said suction pipe.